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# E-learning solutions based on service-oriented technologies

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**Abstract**

Considering the current stage of development, where the nature of work is changing and moving towards virtual organization of activities, the educational process also undergoes deep changes. The effect of these changes is widely known as e-learning. The importance and marginal utility of e-learning become obvious against the background of world crisis. These are only a few reasons behind the unsurprising adoption of e-learning on global scale. Yet, the simple implementation of e-learning solutions is not enough to guarantee the success of this modern education technology. A successful solution will have to combine the human resource with the modern service-oriented technology. In this paper we will present the most important aspects of implementing a successful e-learning solution. They are: the current stage of implementing e-learning solutions in Romania and worldwide, modern technologies for e-learning, successful projects and case studies, conclusions and future research.



*Keywords:* E-learning; service-oriented technology; standards; assisted training; open source solutions;

## 1. Introduction

One of the current trends in e-learning is to standardize the structure and design of such systems. Any training system (regardless of technology employed – computer based or non-computer based) is imagined through the definition of the learning-training process, which implies a multitude of actors, resources, activities, methods, media etc., all connected by a network of relations. The trend toward standardization aims to achieve the interoperability of various e-learning systems, the full portability and compatibility between platforms, media, systems so that the concepts of continuous learning, distance learning, personalization and user-centered may be applied on large scale. (Stoica & Ghilic-Micu, 2009). Application design trends have evolved from rigid structures towards flexible architectures. Interactions between business partners have shifted from static agreements to dynamic ones. Business-to-business integration processes have changed from technology based integration to business process based integration. There is a corresponding mutation in the programming models and architectural design, in order to activate these trends – from string coupled applications to weak coupled services.

These tendencies are making their way ever stronger in the educational field, converging to current practices. Evolution has reached the point where technologies like Enterprise Java Beans, .NET or CORBA have become efficient ways to implement software components, while component based development ensures faster and more efficient creation of new systems. From technical perspective, there are significant changes in the flexibility and interoperability, with the support of open and largely accepted standards. First major change took place when the

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TCP/IP was released as open platform for network communication. This step has led to the emergence of important and widely used architecture, like client/server. The raise of World Wide Web sprung the next mutation, HTML and HTTP providing the first really portable open interface and finally XML brought open and portable data exchange. The next step in the evolution of open standards is the integration through web services.

## 2. Modern technologies for e-learning – service-oriented architectures

Current web and internet specifications, although evolving at fast pace, are inadequate for learning, education and training because e-learning experience means more than "content delivery" and internet access. Beside low costs and specialized e-learning technology, e-learning needs interoperability. Educational and training environments use online distributed technology. All users, providers and institutions look for interoperability and better performance from these various environments.

Service-oriented architecture (SOA) proposes an approach to distributed systems construction that provides the functionality of the application as a service, both for final users and for other services. IT consists of elements that can be classified as belonging to *functional side* or *service quality*. Figure 1 shows the architectural stack and the elements that can be identified in service oriented architecture.

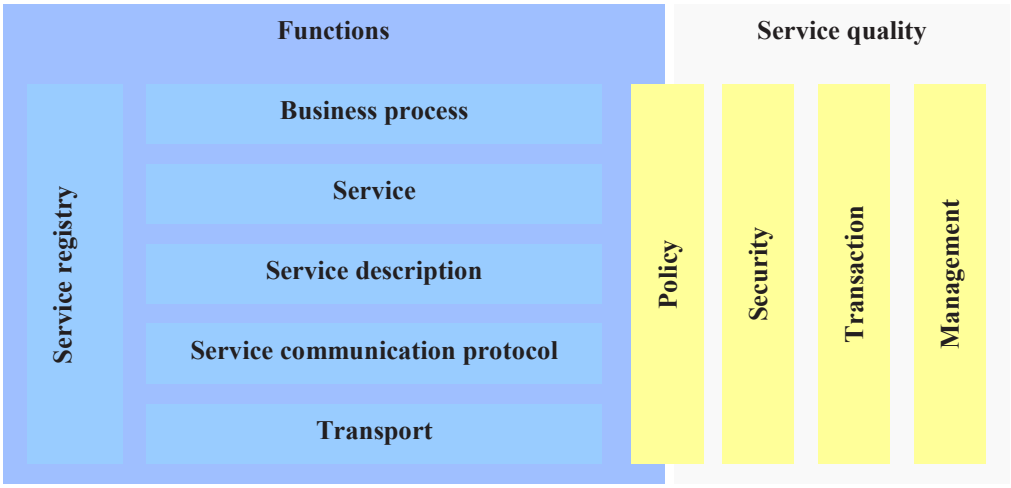


Figure 1. Elements of service-oriented architecture (adapted from Endrei et al., 2004)

The architectural stack consists of two elements. First one contains the functional aspects of the architecture and the second one the aspects related to the quality of services. **Functional** aspects include transport, service communication protocol, service description, the service itself, the business process and the service registry.

- *The transport* is the mechanism used to carry the service requests from the service consumer to the service provider and the request responses from the provider back to the consumer.
- *Service communication protocol* is an accepted mechanism used by the service provider and consumer in order to communicate the requests and the responses.
- *Service description* is an accepted schema for the description of what the service is, how to invoke it and what data is needed for a successful invocation of the service.
- *The service* describes an actual service offered to eventual consumers.
- *The business process* is a collection of services, invoked in a certain order, according to a set of rules, in order to complete a business request. The business process may be considered a service itself which leads to the idea that a business process could be built from services with various granularities.

- *The service registry* is a repository of data and service descriptions which can be used by service providers to publish their services and by consumers to discover of find the available services. The service registry may also provider additional functions for the services that require a centralized storage.

**Service quality** related aspects include:

- *The policy* is a set of conditions and rules under which a provider makes the service available to the consumers. There are functional aspects of the policy and aspects related to service quality. This is why the policy is the link between the functional area and the service quality.
- *Security* represents a set of rules which may be applied to consumer identification, authorization and access control when they request services.
- *The transaction* is a set of attributes that may be applied to a group of services in order to provide a consistent result. For example, if three services are required for a business function, they all must end (or none of them).
- *The management* is a set of attributes that may be applied to the management of consumed services of provided services.

In service-oriented architecture, the services lead to the business functions that were identified during the analyses of the business process. The services may be coarse of finely granulated, depending on the business processes. Each service has a well-defined interface that allows it to be published, discovered and invoked. A business may choose to publish its services to external business partners or within the organization. A service may be also composed from other services.

As with any business, there are two main concerns related to e-learning: the ability to change fast and the need to cut down the costs. In order to remain competitive, the businesses must adapt quickly to internal factors (like mergers and restructures) or external factors (like competition forces and client demands). In order to support a high performance e-learning project, a flexible and economically efficient IT infrastructure is required.

A possible answer is the service-oriented architecture, which may provide a series of advantages (Duan & Hosseini, 2006) that help e-learning projects achieve success in the dynamic environment of today:

- *Making use of existing resources* – SOA provides an abstract layer that allows a business to continue to benefit of IT investment, exploiting these resources as services that provide business functions.
- *Easier integration and management of complexity* – the entry point in the service-oriented architecture is the service specification, not the service implementation. It provides transparency to the implementation and minimizes the impact in case of infrastructure or implementation changes. Providing a service specification in front of the existing resources and values, built on various systems, makes integration easier to manage because the complexities are isolated.
- *Better reaction speed and lower "time-to-market"* – the ability to compose new services from the existing ones brings the distinct advantage to educational units that must be agile in responding to ever more diverse demands of the market. Taking advantage of the existing services and components may reduce the time required to complete the software development cycle, by speeding up gathering of requests, project implementation, development and testing.
- *Reduced costs and higher reutilization* – central services of an e-learning project are exposed in a loosely coupled manner so they can be used and combined easier, based on current needs. This means less duplication of resources, better potential for reutilization and lower costs.
- *Preparation for upcoming events* – SOA helps maintain the open doors statute for the e-learning future. Educational services made up of a series of specific services are easier to create, change and manage in order to answer current opportunities. SOA brings flexibility and reaction speed, critical elements for any business from functional and development perspective.

Service-oriented architecture can be successfully implemented only under a dynamic approach, continuously changing as result of transformation in the external environment. When developing a new application, the SOA approach allows for easier reutilization of existing subsystems, no matter of the programming language used, if standard communication protocols are observed.

## 3. Successful projects and results

The internet based laboratory (online laboratory) is a continuously developing research theme in universities. It is often called virtual laboratory, distance laboratory, internet laboratory or Web laboratory. In the existing e-learning systems the hardware equipment is not supported by the e-learning infrastructure, although IMS Learning Design Best Practices and Implementation Guide (IMS, ver. 1.0, 2003; Can, 2009) present a few examples of virtual laboratories. These examples can be chosen for the validation of a conceptual model of the learning system. Anyway, they do not give design and implementation details for learning platforms based on laboratories.

The main objective of such architecture is to combine researches from the online laboratory and e-learning infrastructure in order to achieve the objective of increasing opportunities and learning experiences for students. The architecture in figure 2 is based on SCORM specifications for e-learning systems (Casella et al., 2007) with additional modules (apparatus – LMS) and is based on the functionality of hardware based learning systems. ADL's SCORM specification (Advanced Distributed Learning) concentrates on the content of learning resources (launching it, communication and monitoring its path between learning resources and the learning system management). It provides the means to reuse the learning resources and interoperability between multiple LMS/LCMS systems. The specification consists of the following 3 components:

- Learning resources – products (web page, JavaScript, XML documents, Flash objects, figures etc.) and shareable content objects (a collection of one or more products);
- LMSAPIs – communication mechanism between LMS and SCO (Shareable content object), used to collect data regarding the learning process;
- SCORM execution environment – a learning management system that manages the students' activity and e-learning objects in order to collect data about the student's progress.

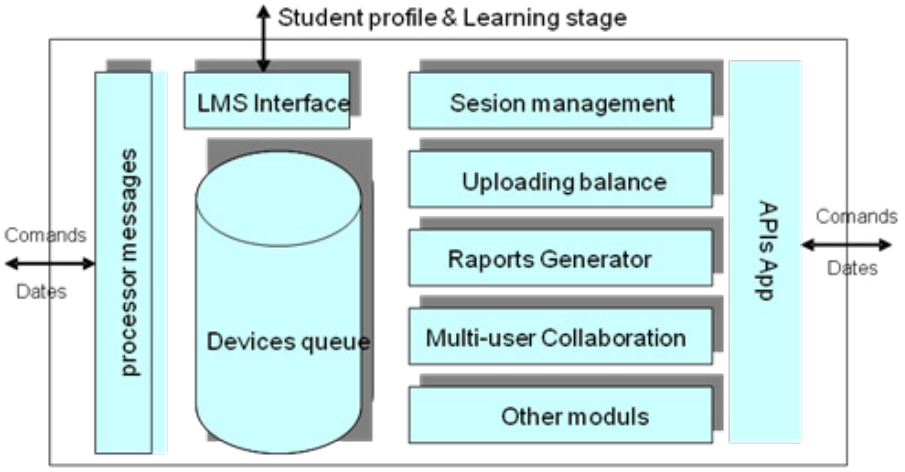


Figure 2. Architecture of an e-learning system

The Academy of Economic Studies of Bucharest has implemented an integrated information system for university management (SIIMU) as a solution for the management of learning activities in a service oriented architecture. SIIMU has specialized components for the actors of the learning process (students, professors and management). They are divided into specific components for every level of higher education: bachelor, master, doctoral, day courses and distance learning.

## 4. Conclusions and research directions

Education, training, content development depend on collaboration and cooperation. Institutions and providers cannot develop all the learning materials and resources, therefore organizations must collaborate, reuse and sell learning resources. International standards are crucial for a successful collaboration between organization and for content reuse. Successful international standards allow institutions to and other users to buy technology that works well and is interoperable. Development and use of international standards leads to decreased costs and technological systems may be used for a broader range of applications, raising the efficiency and ensuring a high quality of learning services.

IT managers and professionals alike believe that we now very close to solving many of the heterogeneity, interoperability and continuous change problems, through service oriented architecture. Such architecture must provide a loosely coupled platform, transparent to location and independent of protocol for building application services. Based on service oriented architecture, the service consumer will not even have to be concerned about the service he is communicating with because the infrastructure supporting it will make the adequate choice in consumer's name. The infrastructure hides as many technical details as possible from the user.

Still, service-oriented architecture is no miracle solution and migration towards SOA is not an easy task. It is not important to migrate the whole technological infrastructure overnight, but to migrate the right subset of functions of the e-learning process, as the business needs arise or are anticipated.

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